Use of a UAV-Mounted Video Camera to Assess Feeding Behavior of Raramuri Criollo Cows

Shelemia Nyamuryekung'e [1], Andres F.Cibils [1,], Richard E. Estell [2], Alfredo Gonzalez [2]*

[1] Department of Animal and Range Sciences, New Mexico State University, Las Cruces, NM, 88003, USA
[2] US Department of Agriculture-Agricultural Research Service, Jornada Experimental Range, Las Cruces, NM 88003, USA.
* Corresponding author email: acibils@nmsu.edu

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Introduction

The use of unmanned aerial vehicles (UAVs or drones) in science and engineering has increased dramatically in recent years (Harris 2013). Although US government regulations currently constrain the use of this tool for research (Vincent et al. 2015), it is likely that in the near future UAVs will become the preferred remote sensing platform for applications that inform sustainable rangeland management (Rango et al. 2011). The objective of this study was to determine whether UAV video monitoring could be used to predict intake of discrete food items of rangeland beef cows exposed to a controlled foraging environment.

Materials and Methods

We conducted a series of arena tests with 35 non-nursing adult rangeland-raised Raramuri Criollo cows weighing approximately 360 kg at the USDA-ARS Jornada Experiment Range in New Mexico, USA. Animal handling protocols were approved by NMSU IACUC (Protocol 2015-012). Video footage of all arena tests was acquired with a 3D Robotics Y6 Multi-copter (3D Robotics, Berkeley, CA) fitted with a 2 axis Brushless Gimbal with a BaseCam open source controller and a GoPro Hero 3 Silver Digital Camera (GoPro, San Mateo, CA) shooting 30 FPS at 1080i.

Pilot tests were first conducted to determine whether the sound of the UAV altered the feeding behavior of cows. Twelve feed containers were arranged in an open semicircle in a 405 m^2 rectangular arena devoid of vegetation. Bowls were numbered and placed approximately 1m apart. Each bowl contained either alfalfa hay (AH, 200g), Sudangrass hay (SH, 200 g), or cottonseed cake (CC, 50g). Four bowls of each food type were alternated (CC, AH, SH) using the same sequence in all tests. Pairs of either UAV-adapted or UAV-naïve cows were exposed to the experiment arena for 12 min. In all tests, the UAV was flown at an altitude of 25 ± 2 m above ground level, and typically hovered over the arena and was returned to home base as soon as cows were removed from the arena. Immediately after each trial, food orts from each bowl were collected and bagged separately and each bowl was replenished with the appropriate type and amount of food. All orts were weighed later that day.

Two months later, we conducted experiment tests with a different group of 15 adult non-lactating cows to determine whether UAV video monitoring could be used to predict intake of known amounts of discrete food items. Given the results obtained during pilot tests, no adaptation to the UAV sound was conducted prior to experiment tests. Arena layout and amount and types of food offered were identical to the pilot tests. Cows were led into the arena individually in random order and were allowed to feed from bowls for approximately 4 min. Test length was determined by UAV battery life, which typically supplied power for 5 to 6 min flights. Each test was filmed with the UAV deployed from a nearby location, again at an altitude of 25 ± 2 m. Food orts collection and weighing was conducted as described above.

All video files were downloaded and later processed to extract 2 sec. interval still images. A total of 4,893 images were inspected. Number of images indicating length of visits to bowls with AH, SH, and CC during each arena test were added and expressed as a frequency (%) by dividing number of visits to bowls containing a given food item by the total number of still images extracted from the video footage of a given test. Frequency data gathered in the pilot tests were analyzed with a t-test to determine if UAV-naïve and UAV-adapted animals exhibited different feeding frequencies. Data from the experiment tests were subjected to Linear Correlation analyses to determine the relationship between video-derived feeding frequency of individual cows and amount of food consumed per bowl (g*bowl visited^{-1} or rank). All analyses were conducted in SAS 9.3 (SAS Institute, Cary, NC). Differences between means or relationships between variables were considered statistically detectable at $P \leq 0.05$.

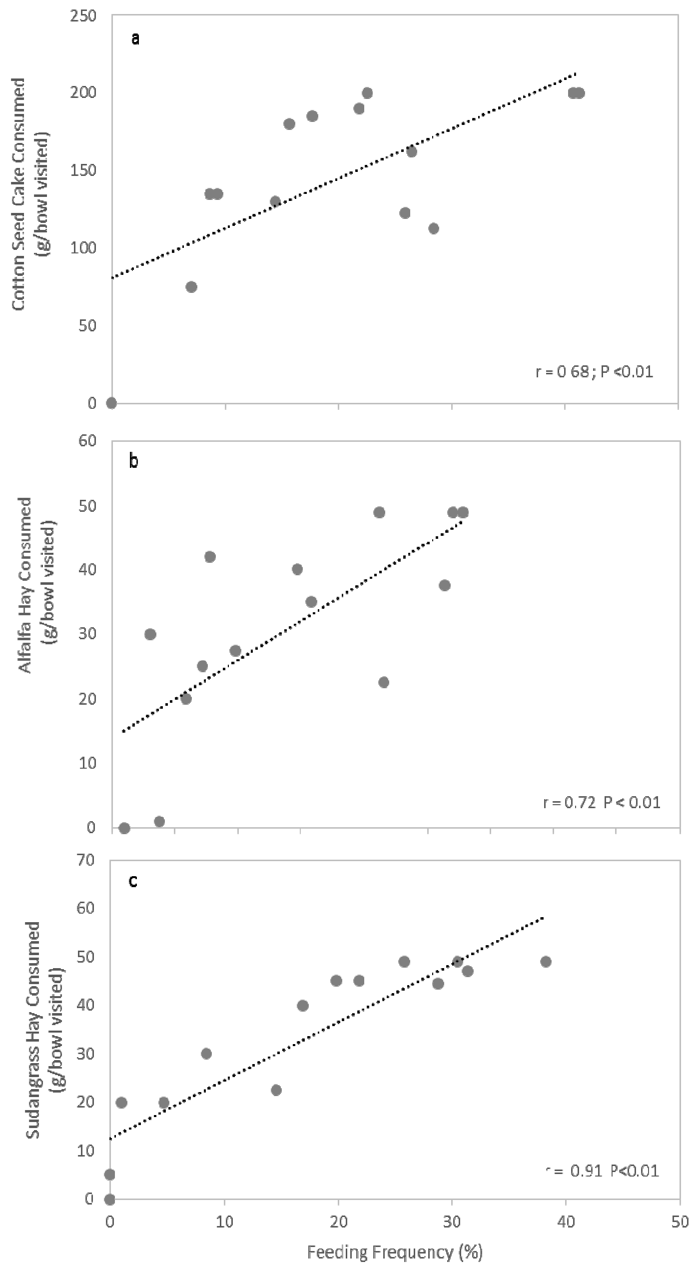

Figure 1: Relationships between feeding frequency (%) of 14 indi-vidual cows and: grams of cottonseed cake (a), alfalfa hay (b), and Sudan-grass hay (c) consumed per bowl visited during 4 minute arena tests with non-nursing mature Criollo cows.

Results and Discussion

Pilot tests showed no difference in feeding behavior of UAV-naïve and UAV-adapted cows, suggesting that this monitoring technique could provide an adequate non-invasive means of descri-bing behavior of non-adapted rangeland beef cows. Experiment tests showed strong positive correlations between feeding frequency observations derived from UAV video footage analysis and the amount of food consumed per bowl visited by cows (Fig. 1). This relationship was strongest for Sudan grass hay (r 0.91; P< 0.01) and weakest for cotton seed cake (r 0.68; P< 0.01).

Implications

Further development of UAV power sources to provide greater flight autonomy will be needed to use this tool in rangeland environ-ments. Because UAV image acquisition is spatially explicit, the integration of video from improved UAVs coupled with wireless transmission of acoustic signals from microphones fitted on grazing animals could provide unpre-cedented opportunities for integrating the study of diet and habitat selection of free-ranging livestock.

References

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